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Color variation in some of the fungi

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The present short paper is the outgrowth of a year spent at the New York Botanical Garden as Columbia University fellow in botany, during which a large amount of time was spent in the study of the North American Hypocreales, the main results of which are still unpublished. The order Hypocreales belongs to the group of fungi commonly known as the Pyrenomycetes and is distinguished from the other orders of the group by the absence of black color. Instead of the black charcoal-like appearance the plants of the order show almost every conceivable shade, the individuals as a whole probably being more brilliantly colored than those of any other group of fungi and doubtless rivaling, in this respect, any other group of plants. But notwithstanding their brilliant colors, many of the plants of the order are so small and occur in such unexpected places that they escape the eye of the casual observer and often that of the more trained collector as well.

Probably no character is of more importance, if properly used, in the determination of species among the fungi than that of color, and at the same time no character has been so sadly misused. More synonyms in the present order owe their origin to lack of knowledge of the amount of variation of color in the various species of the order than to any other one fact. To describe a new species of maple which is distinguished from some of the species already described by the fact that the leaves are red instead of green would be considered absurd by students of higher plants, yet many species of fungi have been "made" on characters which are just as striking and also just as valueless as the one just suggested. The few corrections which are set forth here are made, not in the spirit of criticism, but with the hope that they may prevent some of the similar errors which otherwise might occur in the future. It is much more difficult to study the life-history of plants which are but a fraction of a millimeter in diameter than that of the higher plants which stand often many meters in height. Yet, if the existence of

these minute organisms is worthy of record at all, as the true lover of science will admit they are, they should deserve just as careful study through all the phases of their life history as do the higher plants, which on account of their large size force themselves upon our attention.

One of the first observations of color variation to come under the eye of the writer was in connection with the study of *Nectria purpurea* (L.) W. & S. (Jour. Myc. **13**: 51), which is more commonly known under the name *Nectria cinnabarina* (Tode) Fries. While collecting in the vicinity of Mt. Pleasant, Iowa, on November 10, 1905, a brush pile was found to be almost entirely covered with the plants of this species, which showed the characteristic cinnabar-red color and a collection of the material was made at this time. A few months later the same spot was visited again with the hope of making a second collection of the same species. The old plants still persisted but were so changed in color as to be scarcely recognizable, the perithecia having become very dark brown and in some cases entirely black. A second collection was made at this time and when compared with the first showed such a marked difference that, were color alone considered, they would constitute two well-defined species. Yet, these two specimens were known to represent the same species collected at different times. A careful study of this species in the laboratory and field has shown the range of coloration to be from bright cinnabar-red when collected in good condition to dull red, light brown, dark brown and finally black, with an infinite number of intermediate shades, the change coming about through weathering and varying conditions of moisture. The originally bright color of the plants and their xerophytic nature, which enables them to persist for a long time, often several months, after maturity, are sufficient to explain the cause of these variations.

In working over the various species of the genus *Nectria* preparatory to a monograph, several species which had been recorded in previous North American monographs had been tabulated in the notes of the writer as "suspicious characters" on the ground that the descriptions were too brief and indefinite to give any conception as to the real nature of the specimens described and in most cases gave no character which could be considered as dis-

tinctive of the species except color, which in this genus is very uncertain. Several of the species belonging to the doubtful list were from the notorious "B. & C." collections. In every case an attempt has been made to gain access to the type specimen of such species. Through the authorities of the New York Botanical Garden we have succeeded in securing several cotype specimens from the Royal Botanic Gardens at Kew and here it might be well to acknowledge the liberality and promptness with which such requests were granted by those in charge of the Botanic Gardens of England. Where specimens were too fragmentary to divide, pencil sketches were carefully prepared which have aided much in shedding light on some of the mysteries surrounding the group under consideration, although drawings do little to clear up the color question.

Some of the doubtful species of which the cotypes have been examined are *Nectria Russellii* B. & C., *Nectria offuscata* B. & C., and *Nectria nigrescens* Cooke. The first two were originally described in the following manner (Grevillea 4 : 45) : "Cespitose, red inclined to brown, finally collapsing ; spores cymbiform, 1-septate, 15 to 20 mic. long," and "Cespitose, dingy red-brown, minutely granulated, ostiolum depressed ; asci clavate ; spores 2-seriate oblong, 4 times as long as broad." In neither of these descriptions is there a single character mentioned which would distinguish the supposed species from *Nectria purpurea* (L.) W. & S., when the range of coloration of this species is taken into consideration, and a careful examination of the cotype specimens of each of these species also fails to reveal any valid specific character. The third of these doubtful species is described (Grevillea 7 : 50) as follows : "Cespitose, red, at length turning black, smooth, ostiolum papilliform ; asci cylindrical, spores elongated-elliptical, 1-septate, 18 by 6 mic.; stylospores on the same stroma, some ovate brown (5 by 3 mic.), others linear (6 by 2 mic.), hyaline." The only character in this description which might mark a new species is the presence of the brown stylospores and there is no evidence given that these are connected with this plant even though present on the same stroma. Examination of a specimen of this species from Kew shows unmistakable evidence of age and partial decay. The perithecia are blackened and in many cases crumbled and it is dif-

difficult to find asci and spores, all of which are indications of the age of the specimens at the time of collection. The brown stylospores mentioned in the description were not seen and even though present, as suggested above, there is no evidence that they form a part of the life-history of the plant with which they are found. The specimen has every appearance of being a discolored specimen of *Nectria purpurea* (L.) W. & S.

Nectria Meliae Earle (Bull. Torrey Club 25: 364) is said in the original description to be distinguished from *Nectria purpurea* (L.) W. & S. by the darker color of the perithecia and a slight variation in size. Examination of specimens of this species in the herbarium of the New York Botanical Garden shows no grounds for its separation.

No species deserves more careful study than the one now under consideration for the reasons that it is common and widely distributed, occurs on nearly every kind of tree and shrub, and, being a persistent form, shows much variation in color as well as in other characters which would naturally be affected with age. A large number of the closely related so-called species which have been described are distinguished primarily on color and if every shade of color be accepted as a valid specific character we might have an infinite number of "printer's ink" species created from the one form as set apart by nature.

Another case of color variation has been noted in *Hypocrea gelatinosa* (Tode) Fries (Fung. Meckl. Sel. 2: 46. f. 123, 124). Specimens of this species collected by the writer show the very young plants to be of a bright lemon-yellow color, but as the spores mature they become olive-green, giving to the stroma a mottled appearance. The whole stroma then becomes darker until it assumes a dirty green, finally becoming nearly black with age. In fresh specimens all of these variations have been seen on the same substratum and the relation can be traced from one to the other.

Hypocrea chlorospora B. & C. (Grevillea 4: 14) is characterized as being distinguished from the above by the black stroma, the color of the spores being the same in both species. While no authentic specimen of this species could be secured, it seems very doubtful if it is distinct from *Hypocrea gelatinosa* (Tode) Fries.

In the Ellis collection at the New York Botanical Garden is a specimen of green-spored *Hypocrea* labeled, evidently in the handwriting of Mr. Ellis, "*Hypocrea viridis* n. s." and the stroma described as being dull greenish within and without, and a note is added stating that it could not be *Hypocrea chlorospora* B. & C. for the reason that that species was characterized by a black stroma. Another note, added, apparently, at some later time, stated that as the plant dried it became darker and might after all be *Hypocrea chlorospora* B. & C.

Still another specimen of green-spored *Hypocrea* was described by Mr. Ellis as being at first yellowish. Both of these specimens when examined in 1906 showed the stromata to be entirely black with a greenish bloom, which came about from the dusting out of the spores from the perithecia.

The notes on the specimens in the Ellis collection, as well as the observations of the writer on both herbarium and fresh material which has been collected often and in various localities, tend to confirm the opinion that *Hypocrea chlorospora* B. & C. is identical with *Hypocrea gelatinosa* (Tode) Fries and that the range of coloration in this species is from bright golden or lemon-yellow in very young specimens to dirty greenish as the spores mature and finally black with a greenish bloom, which comes from the dusting out of the spores from the perithecia as the specimens become more aged.

This view is strengthened by the fact that Tode in his original description recognized two varieties, *viridis* (green) and *lutea* (yellow), and Fries later recognized a third, *umbrina* (dark).

Hypocrea apiculata Cooke & Peck (Ann. Rep. N. Y. State Mus. 29: 57) also shows some rather marked color changes. This species has been studied from numerous collections of fresh material, the identification of which has been confirmed by Mr. Peck, one of the authors of the species. In specimens collected in good condition the stromata are of a bright orange-yellow color. If specimens are dried and exposed to the light for some time the color becomes lighter until it assumes a dirty yellowish and finally becomes almost white or a dirty yellowish-white. In this case the bleached specimen might easily be mistaken for a distinct species considering the importance which has usually been attached to the color character in this genus.

One of the most striking cases of color variation has been observed in *Hypomyces lactifluorum* (Schw.) Tul. (Syn. Fung. Car. 4). This species has been studied from various exsiccati in the herbarium of the New York Botanical Garden, including both American and foreign specimens and during the past season ample opportunity has been afforded to carry on field observations with the same species.

Hypomyces purpureus Peck (Bull. Torrey Club 25: 327) is stated in the original description to differ from *Hypomyces lactifluorum* (Schw.) Tul. only in the color of the stroma, which is purple instead of orange-yellow. Studies in the herbarium convinced the writer that the two species were identical, but for lack of suitable material the matter could not be demonstrated absolutely. From recent studies in the field the fact has been established beyond the shadow of a doubt.

During the last season in a piece of aspen timber on the Red River near Fargo, North Dakota, numerous specimens of *Lactaria* were found, all of which were entirely parasitized by *Hypomyces lactifluorum* (Schw.) Tul. The normal color of the plants of this species is a bright orange-yellow and the striking character of the color might be illustrated by the following incident: The collector on returning from a collecting trip with a basket partially filled with the plants of this species chanced to pass a vehicle in which a little boy was heard to remark to his mother "O mama, see the big basket of orange peel!" While most of the specimens collected showed the normal orange color, in looking over the field a number were noted which showed the purple color characteristic of *Hypomyces purpureus* Peck. But in every such case the host showed evidences of decay and in advanced cases the host had become soft and fallen in a heap. In these extreme cases of decay the purple color was very prominent and would readily suggest to the mind of the collector the association of the purple color with decay.

In order to test the matter a simple experiment was conducted. A plant which showed the normal orange-yellow color was selected and cut into two pieces. The one was placed in a moist chamber and the other dried at once. As the moist specimen decayed, it assumed the characteristic purple color of *Hypomyces purpureus*

Peck and the other half which was dried immediately retained the orange-color of *Hypomyces lactifluorum* (Schw.) Tul. thus proving the identity of the two species. Dried specimens of each were mounted in the herbarium of the writer and kept for future reference.

Colors are not equally changeable in all cases, neither are the conditions which bring about these changes the same for different species. In *Hypocrea citrina* (Pers.) Fries, which is normally of a bright lemon-yellow color, the dried specimens have been exposed to the light for several months and no change in color detected, while specimens of *Hypomyces apiculata* Cooke & Peck are entirely bleached when treated in the same manner. However, *Hypocrea citrina* (Pers.) Fries, if exposed to conditions of excessive moisture, loses its bright color and takes on a dull yellow, approaching a brown.

The conclusions of the present paper are that the evidence, which is adequate in most cases, suggests the reduction of the following species which are based primarily on color to the list of synonyms: *Nectria Russellii* B. & C., *Nectria offuscata* B. & C., *Nectria nigrescens* Cooke, and *Nectria Meliae* Earle, being based on aged and more or less discolored specimens of *Nectria purpurea* (L.) W. & S.; *Hypocrea chlorospora* B. & C. on an aged specimen of *Hypocrea gelatinosa* (Tode) Fries; and *Hypomyces purpureus* Peck a condition of *Hypomyces lactifluorum* (Schw.) Tul. in process of decay. Further, that the description of new species in the present order based on color *alone*, until the color variation of the various species or the order can be determined, leads to nothing but confusion. Only a few of the more striking cases of color variation have been mentioned here and those with the hope of impressing upon co-workers the necessity of more careful field study rather than a haphazard description of new species based on characters which may prove constant but which in many cases are most changeable.

A monograph of the North American Hypocreales is in course of preparation by the writer and material is desired from any part of North America.

In preparing this paper I am indebted to the New York Botanical Garden for unrestricted use of library and herbarium,

including the Ellis collections, and to the Royal Botanic Gardens of England for the several cotype specimens referred to in the paper; also to Mr. C. H. Peck for the determination of one species used and to the late L. M. Underwood for suggestions on various points.

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